



# Disturbance of Harbor Seals by Vessels in Johns Hopkins Inlet

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## Introduction

Harbor seals (*Phoca vitulina richardii*) are one of the most abundant marine mammal species found across the Pacific Rim, ranging from Baja California to the Bering Sea. Although they spend much of their time in the water, foraging in diverse aquatic habitats including small lakes, large rivers, and open ocean, harbor seals, like other species of seals and sea lions, need to frequently exit the water ('haul out') to rest, give birth, and nurse pups. Seals haul out on land or ice, and may occur in large aggregations, particularly in glacial fjords. For example, in Icy Bay, Alaska, over 5,000 harbor seals may haul out at certain times of the year.

Harbor seal haulouts are popular destinations for private vessel operators, eco-tours, and cruise ships (Figure 1), but visitation by vessels can result in disturbance of seals. Disturbances can be subtle and somewhat benign, such as a seal lifting its head to look at an approaching vessel, or more severe, such as when vessels cause seals to flush from their haul-outs (land or ice) and enter the water. Flushing is problematic because it is energetically costly, particularly during molting, when seals shed and replace their fur coat, and may impact reproductive success by separating mother-pup pairs, or interrupting nursing.

In Glacier Bay National Park and Preserve (GLBA), certain areas of the park are subject to vessel regulations that are either generally or specifically mandated to protect seals from the deleterious impacts of disturbance. For example, in the lower section of

the park, harbor seals regularly haul out on land at the Spider Island Reef Complex. Throughout the year, vessel operators are required to stay at least 0.25 nautical miles (463 m) from these islands in order to minimize the chance of disturbance to harbor seals. Likewise, Johns Hopkins Inlet, where up to two-thirds of seals in the park haul out on icebergs during the summer, has been designated "critical seal habitat." This designation affords seals extra protection from disturbance through specific management regulations (Figure 2).

Despite these regulations, there is concern about the impacts of vessels on ice-hauling seals in Johns Hopkins Inlet because it was historically home to one of the largest breeding aggregations of seals in Alaska (Streveler 1979) but the abundance of seals has decreased precipitously since 1992 (see Womble *et al. this issue*). To date, a number of hypotheses have been proposed as to why seals have declined in Glacier Bay, including changes in prey base, increased levels of predation, and vessel disturbance. Vessel disturbance was important to evaluate because disturbance, unlike natural stressors, can be regulated by park management. Furthermore, several opportunistic reports suggested that compliance with regulations has been minimal.

## Methods

The objectives of this study were to characterize and quantify the disturbance regime experienced by seals in Johns Hopkins Inlet. To do so, we established a field camp in the inlet for two to four weeks at a time during the summer field season (June-September) in 2007 and 2008, and recorded information about all vessels (cruise ships, tour vessels, private vessels, and kayaks) (Figure 3). We also assessed haulout behavior of harbor seals by recording behavior of seals (in the absence of vessels) as well as vessel-induced changes in behavior. We then

used these data to evaluate the effectiveness of, and compliance with, existing management regulations.

## Results

Over the course of the study we were in Johns Hopkins Inlet for a total of 64 days, and observed 178 vessels entering the inlet. Vessel use varied dramatically among days, months, and years. Vessels never entered the inlet in June, which demonstrated 100% compliance with the June vessel restriction regulation. Private and tour vessels entered Johns Hopkins Inlet the remaining summer months, whereas kayaks only entered during July and August, and cruise ships only were present in September (Figure 4).

Vessel behavior in Johns Hopkins Inlet differed among vessel types, and was largely influenced by ice conditions. For example, private and tour vessels tended to stay along the edges of ice floes, only approaching Johns Hopkins Glacier when ice was sparse or if there was an ice-free lead through the inlet. Cruise ships, on the other hand, frequently traveled to the head of the inlet, regardless of ice conditions. Kayaks, in contrast, generally avoided dense ice, and often turned around at the mouth of the inlet when ice cover was substantial.

The daily number of seals flushed by vessels ranged from 0 to 63 with an average of 15 per day attributed to vessels. Consequently, the flush rate (37%) in the presence of vessels was nearly double that compared to when vessels were absent (17%). However, not all vessel types were equally disruptive: 86% of cruise ships flushed at least one seal, followed by tour vessels, private vessels, and kayaks (Figure 5). Cruise ships caused the greatest magnitude of disturbance, flushing an average of 11.5 seals per vessel, followed by private vessels (7.5 seals), tour vessels (4 seals), and kayaks (3 seals).

As seals in the inlet typically hauled out in the areas of densest ice cover and because vessel behavior was

**Figure 1. A cruise ship approaches an ice berg upon which several seals are hauled out.**

NPS photograph by Jamie Womble

Regulation	Geographic Area	Timeframe
Vessel access restriction – all vessels	Johns Hopkins Inlet	1 May – 30 June
Vessel access restriction – cruise ships	Johns Hopkins Inlet	1 May – 31 August
0.25 nm minimum vessel approach distance to harbor seals	Johns Hopkins Inlet, Spider Island Reef Complex	1 July – 31 August
10-knot speed limit when operating around harbor seals	Johns Hopkins Inlet	1 July – 31 August
Daily vessel quotas – Cruise ships: 2 Tour vessels: 3 Private vessels: 25	Glacier Bay National Park	1 May – 30 September 1 May - 30 September 1 June – 31 August

largely dependent on ice conditions, the propensity for vessel disturbance of seals was impacted by ice cover. In general, vessels that were further from seals were less likely to cause a disturbance. The cumulative frequency of flushing versus distance (*Figure 6*) illustrates the relationship between distance and the occurrence of flushing. Nevertheless, the response of harbor seals to approaching vessels was extremely variable with some animals flushing at great distances from vessels, while others seemingly ignored vessels completely. Our results indicated that, in addition to ice cover, vessel approach distance and vessel type were important variables to include when predicting the probability of flushing.

Whether, and to what degree, vessels were in compliance with seal disturbance laws and regulations depended upon whether the regulation specified separation distance with seals or modification of their behavior. For example, if we defined disturbance as whether or not a seal flushed from the ice in response to a vessel (independent of the approach distance of the vessel), then 72% of vessels observed during the study caused a disturbance. Only 12% of vessels that entered the inlet on study days fully complied with the 0.25 mile minimum approach distance regulation. Many vessels approached seals within 0.25 mile but did not flush any seals, and

many seals flushed when vessels were at distances greater than 0.25 mile. Among 71 vessels that violated the distance regulation, 936 seals were approached closer than 0.25 mile. These vessels were responsible for 69% of all animals flushed during the study period.

## Conclusions and Management Implications

As expected our study found some management-relevant results but also, as with many scientific studies, generated a number of new questions. The presence of all vessel types in the inlet was found to alter the haulout behavior of harbor seals. The great magnitude of cruise ship-induced disturbance was consistent with studies from other areas (*Jansen et al. 2010*). It is unknown whether cruise ships flush seals at a greater rate because they are larger and can be seen from a greater distance, or because they are more likely to proceed through ice conditions that otherwise prohibit smaller vessels. It is difficult to separate characteristics, such as ship size (would private vessels flush a similar number of seals if they were the same size as cruise ships?), from characteristics like vessel behavior (would cruise ships flush equal number of seals if they avoided dense ice, like private vessels?). Regardless, although responsible for flushing more seals per vessel, cruise ships are restricted to entry into Johns Hopkins

Inlet during September, when seals are not burdened by the energetic demands of pupping and molting.

Overall compliance of vessels with park-specific and federal (Marine Mammal Protection Act) regulations was minimal. Kayaks were the most compliant, though this is probably a result of their reluctance to approach most seals due to ice conditions. Cruise ships, conversely, accounted for the greatest percentage of violations. The overall proportion of the seals that were disturbed by vessels was relatively low. This finding indicates that it is unlikely that disturbance of harbor seals by vessels alone was a driving factor in the historical demographic change, although increased vessel use of the inlet in recent years may be compounding other deleterious factors potentially affecting seals, such as decreased quantity and quality of prey, or disease. The potential energetic costs of flushing, the significance of glacial fjords as critical pupping habitat (thus potential source populations), and the legal obligation to uphold the Marine Mammal Protection Act all underscore the importance of minimizing anthropogenic impacts in Johns Hopkins Inlet.

Based on the findings from this study, we recommend that resource managers consider increasing enforcement of current regulations, potentially modify existing park regulations, and encourage boaters to



Photograph courtesy of Lindsay Carroll

**Figure 2. (Left) Summary of harbor seal related vessel regulations in Glacier Bay National Park and Preserve.**

**Figure 3. (Right) An observer records harbor seal behavior in Johns Hopkins Inlet.**

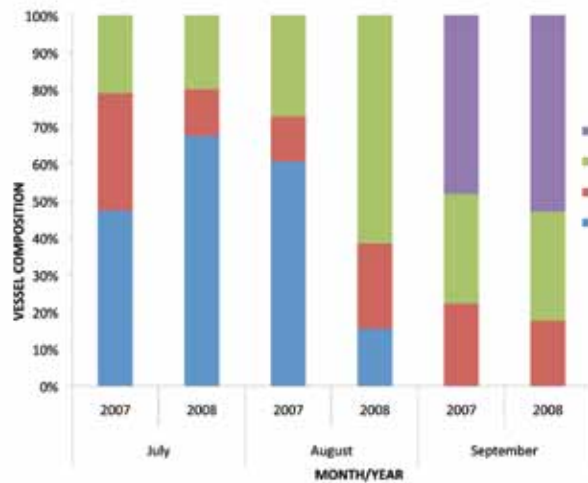


Figure 4. Monthly vessel traffic, by vessel type, in Johns Hopkins Inlet. Vessels were classified as cruise ships (C), tour vessels (T), private vessels (P), and kayaks (K).

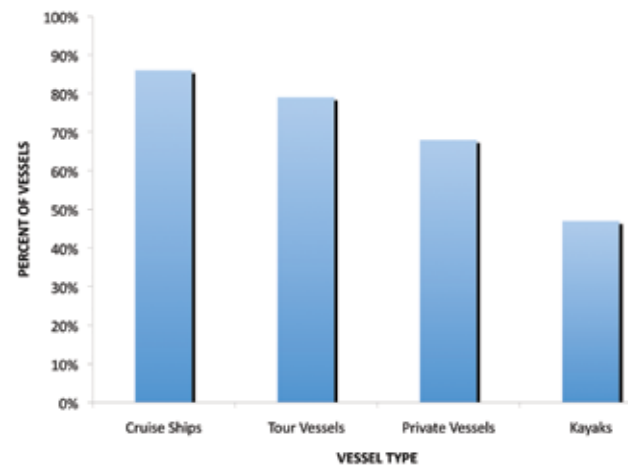


Figure 5. Disturbance rates of harbor seals among vessel types. Disturbance rate was calculated as the percent of each vessel type that entered Johns Hopkins Inlet and flushed at least one seal.

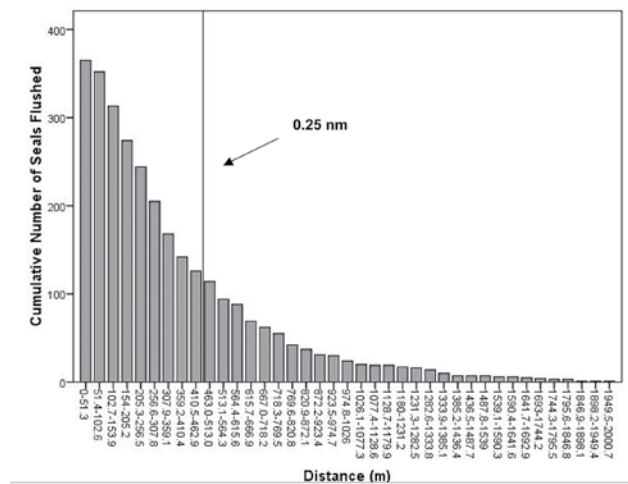


Figure 6. Cumulative frequency of seal flushing based on the distance of an approaching vessel.

Modification	Justification
<ul style="list-style-type: none"> <li>Survey JHI for un-weaned pups before opening JHI to vessel traffic.</li> </ul>	<ul style="list-style-type: none"> <li>Prevent mother-pup separation for late-weaners.</li> </ul>
<ul style="list-style-type: none"> <li>Enhance education of boaters regarding seal-related vessel regulations during backcountry orientation for private boaters, and through a training session or video for tour vessel and cruise ship captains.</li> </ul>	<ul style="list-style-type: none"> <li>Voluntary compliance with existing regulations would probably greatly reduce disturbance of harbor seals in JHI.</li> </ul>
<ul style="list-style-type: none"> <li>Increase enforcement of the 0.25 nm minimum distance requirement.</li> </ul>	<ul style="list-style-type: none"> <li>Enforcement (or threat of enforcement) would likely increase compliance with this important regulation.</li> </ul>
<ul style="list-style-type: none"> <li>Restrict cruise ship visitation of JHI to 5km into the inlet.</li> </ul>	<ul style="list-style-type: none"> <li>The majority of seals haul out near the face of the glacier, so this would greatly reduce the number of potential disturbance events.</li> </ul>
<ul style="list-style-type: none"> <li>Restrict all vessel visitation of JHI to morning and late afternoon hours.</li> </ul>	<ul style="list-style-type: none"> <li>Since fewer seals haul out during these times, the potential for disturbance will be decreased.</li> </ul>

Figure 7. Suggestions for possible modifications to current harbor seal-related vessel regulations.

comply with federal regulations (Figure 7). Adopting one, or a combination, of these modifications may substantially decrease the frequency and magnitude of disturbance of harbor seals by vessels in the inlet.

## REFERENCES

- Jansen, J.K., P.L. Boveng, S.P. Dahle, and J.L. Bengtson. 2010. *Reaction of harbor seals to cruise ships*. Journal of Wildlife Management. In press.
- Streveler, G.P. 1979. *Distribution, population ecology and impact susceptibility of the harbor seal in Glacier Bay, Alaska*. National Park Service. Juneau, Alaska.